ORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. ______

ject No. A-3349 DATE 9/21/82

ject Director: Thomas B. Wells ~~School~~/Lab ECSL

onsor: Harris Corporation, Government Electronics Systems Group, Melbourne Divisions

pe Agreement: Purchase Order No. 0217-2045903

ard Period: From 9-17-82 To 10/1/82 (Performance) 10/1/82 (Reports)

onsor Amount: $4,000 Contracted through:

st Sharing: ______ GTRI/~~GIT~~

le: Conduct an Initial Mesh Reflectance Study

MINISTRATIVE DATA

OCA Contact Faith G. Costello

Sponsor Technical Contact:	2) Sponsor Admin/Contractual Matters:
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fense Priority Rating: N/A Security Classification: N/A

STRICTIONS

Attached N/A Supplemental Information Sheet for Additional Requirements.

ivel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

uipment: Title vests with N/A

MMENTS:

PIES TO:

~~Administrative Coordinator~~ RAN	Research Security Services	EES Public Relations (2)
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counting	Legal Services (OCA)	Project File
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RM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 2/11/83

Project Title: Conduct an Initial Mesh Reflectance Study

Project No: A-3349

Project Director: Thomas B. Wells

Sponsor: Harris Corporation, Government Electronics Systems Group

Effective Termination Date: 10/1/82

Clearance of Accounting Charges: 10/1/82

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice ~~and Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other ____________

Assigned to: ECSL/EED (~~School~~/Laboratory)

COPIES TO:

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Research Property Management
Accounting
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Computer Input
Project File
Other Wells

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

1 December 1982

Harris Corporation
Government Electronics Systems Group
Melbourne Divisions
Melbourne, Florida 32901

Attention: Robert Taylor, 15/417

Reference: Purchase Order No. 0217-2045903
(Georgia Tech Ref. No. A-3349)

Title: Conduct an Initial Mesh Reflectance Study

Subject: Final Letter Report

Gentlemen:

This report describes free space Ku- and Ka-band reflectance measurements of highly reflective meshes developed by the Harris Corporation and tabulates the results of measurements to date.

Harris Corporation provided four numbered mesh samples mounted on fourteen inch square brass frames with a 12-inch by 12-inch opening. Orientations x and y are distinguished since the meshes are not symmetric with respect to 90^{o} rotations. The measurements are to determine the specular reflection for an incidence angle 30^{o} from the normal to the mesh sample. The geometrical configuration is an equilateral triangle with vertices centered on the transmitting horn antenna, receiving horn antenna, and the mesh sample. Alignment of the boresight directions of the transmitting and receiving horns is accomplished by aiming a laser through one of the horns, reflecting the laser beam by a mirror in the plane of the mesh sample, and verifying that the laser beam is centered in the other horn. To facilitate the fine angular adjustments necessary in aligning the system, the mesh sample and the receiving horn are mounted on tripods. This also allows the system to be well above the floor reducing ground reflections. The transmitting system is mounted on a platform that has a manual drive to accurately move the transmitting antenna toward or away from the sample.

In both the Ku- and Ka-band measurements, the receiving system consists of a standard gain horn, an isolator and a diode detector. A Wiltron Model 560 scalar network analyzer is used as a receiver. The mesh is held by a U-shaped mount attached to a tripod. The mount is designed to clamp the edge of the frame between the body of the mount and thin metal plates held on by set screws. The face of the mount is covered by a strip of Eccosorb LS 14 absorber to minimize reflections from the mount. In the performance of measurements the mount is removed from the tripod at each change of sample or sample orientation as well as between repeated measurements of a given sample, orientation, and frequency. The attachment of the mount to the tripod is by a quarter inch bolt and repeatability of position is obtained by a jig attached to the tripod head. It is useful and probably necessary to back the mesh sample with a sheet of low density styrofoam. The styrofoam eliminates motions of the mesh due to random small air currents passing through the mesh and the styrofoam backing has a negligible effect on the measured reflection. This observation follows from the large reflection coefficient of the mesh, which assures a small transmitted field, as well as from the small reflection coefficient of the styrofoam itself. Since the field reflected by the styrofoam sheet must pass back through the mesh to produce an error term, the error term is given by the product of the styrofoam reflection coefficient and the square of the mesh transmission coefficient. Thus this error is least in those cases where a precise measurement is most desirable, i.e., in cases where the mesh reflectance is closest to unity. Similar considerations apply to reflections from the frame that the mesh is attached to. The metal frame has a reflection coefficient of -1. The reflected field E_R can then be written symbolically as

$$E_R = R_{Mesh} \cdot E_{Mesh} - 1 \cdot E_{Frame} \qquad (1)$$

where R_{Mesh} is the reflection coefficient of the mesh and E_{Mesh} and E_{Frame} correspond to some average of the electric field over the mesh and the frame, respectively. The field reflected from a flat metal plate, which is used to provide a reference point or calibration value, can be expressed as in Equation (1) with the parameter R_{Mesh} replaced by -1. The reference flat plate is fourteen inches square as is the frame that the mesh is mounted on. If the mesh is highly reflective, then it has a reflection coefficient very close to -1. It can be shown that the error in the determination of R_{Mesh} from the measurement of E_R in (1) and the reference flat plate measurement is linearly proportional to the deviation of R_{Mesh} from -1 and increases monotonically with E_{Frame}. Thus, defining the deviation r of the mesh reflection from that of a solid metal plate by:

$$R_{Mesh} = -1 + r \, , \tag{2}$$

one measures

$$E_R/E_{Ref} = \frac{(-1 + r)\, E_{Mesh} - E_{Frame}}{-E_{Mesh} - E_{Frame}}$$

$$= 1 - r\ [1 - E_{Frame}/E_{Mesh} + E^2_{Frame}/E^2_{Mesh} + \ldots]$$

$$= -R_{Mesh} + r\ [E_{Frame}/E_{Mesh} - E^2_{Frame}/E^2_{Mesh} + \ldots] \, ,$$

where E_{Ref} is the field reflected from the flat plate. The second term is the error term due to the frame and it could be corrected if the phase and magnitude of E_{Frame} and E_{Mesh} were determined. Note again that the error term is smallest for the most reflective meshes so that this measurement is best adapted to highly reflective samples.

It is advantageous to reduce the above error term by minimizing the ratio E_{Frame}/E_{Mesh}. This is accomplished by working in the near-field of the transmitting horn at such a distance that the frame is not strongly illuminated. By a reciprocal argument, it is advantageous to work in the near-field of the receiving horn so as to reduce sensitivity to the field scattered by the frame and the surroundings. Thus the symmetrical arrangement of the transmitting and receiving horns appears sensible. The specific separation of the horns from the mesh sample, nominally 20 inches for both Ku-band and Ka-band, was calculated so that the first null in the H-plane pattern of the standard gain horns should be on the frame at a mid-band frequency. The measured reflection from a bare frame was ~ 24 dB below that of a flat plate at the lowest Ku-band frequency and ~ 26 dB at the lowest Ka-band frequency. The measured reflection decreased within each band with increasing frequency (and hence increasing directivity). Note that the frames holding the mesh are partly covered by the mesh and by glue so that the effective reflection coefficient of the frame is not -1 as it is for the bare frame. This is an additional error and strengthens the argument for minimizing the field incident on the frame.

The transmitting system consisted of a standard gain horn, a directional coupler and detector to provide a reference signal and a Weinschell sweep generator. The sweep generator is coupled to an E.I.P.

locking counter to provide a precise stable frequency, phase-locked signal. At Ka-band a waveguide output port Ka-band head is used with the Weinschell sweep generator.

The centers of the transmitting and receiving horns and of the mesh sample lie in the same horizontal plane. The transmitted (and received) polarization is vertical. For each sample at each frequency for both x and y orientation of the sample, the reflection measurement is repeated three times. (The x or y orientation of the sample is specified by the side of the frame labeled x or y being parallel to the floor.) For each measurement, the mesh sample is adjusted manually to maximize the reflected signal. This is necessary each time the sample is put back up to correct slight misalignments. With the sample thus aligned, the transmitting system is moved toward the mesh sample by means of the manual drive noted earlier and the maximum and minimum return of the aligned sample are recorded. The average of this maximum and minimum is compared to the average of the maximum and minimum return from the flat plate as obtained by the same type linear translation. Succinctly the minimum and maximum of the signal correspond to the specularly reflected field, which constitutes the valid signal, being in or out of phase with a background or spurious signal. (The spurious signal includes edge diffraction.) The observation of these minimum and maximum under translation of the transmitting system is a consequence of the specularly reflected field being sampled at points along its propagation direction while the background field is incident from a different direction and therefore varies more slowly between the sampled points. (For example, if one samples a field perpendicular to its direction of propagation, no variation is observed.) To some extent, the success of the measurement using just the maximum and minimum of the reference flat plate reflection and sample reflection depends on the flat plate and sample reflection being similar in phase and amplitude so that details of the background field do not become dominant.

The measurement results are tabulated at the end of this discussion. The columns labeled maximum and minimum are obtained as described above by translating the transmitting horn. The maximum of the return from the flat plate is taken as the 0.0 dB point with all other maximum and minimum expressed in dB relative to 0.0 dB. The flat plate reference measurement must be repeated for each frequency. It was useful to repeat the reference measurement for each sample and occasionally between measurements for a given sample and frequency. The column labeled "Corrected Mean" indicates in dB the ratio of the average field for each measurement to the average for the reference measurement. It would be formally incorrect to average the maximum and minimum power in dB (as opposed to averaging the field magnitudes) but for these highly reflective surfaces averaging in dB will give essentially the same result. Thus one can easily make a rough check of the data. Thus for Sample 1 at 12.5 GHz the dB average for the reference measurement is -0.60 dB and for measurement 1(x) the dB average is -0.795 which is consistent with the corrected mean of -0.20 dB. Averages of the three x orientation measurements and three y orientation measurements as well as a total average for the sample are tabulated for each sample and frequency. As expected, the average reflectance decreases systematically with increasing frequency and with increashing mesh opening size (Samples 3 and 4 have larger openings). Differences between the x and y averages are expected since the mesh is not symmetric under 90^{o} rotations but the observed differences probably also reflect lack of flatness of the samples. Lack of overall sample flatness is probably the largest systematic error source in the present measurements. It is not possible to estimate the size of these errors without precise knowledge of sample flatness obtained at the time of measurement and careful analysis of the near-zone interaction of antennas and mesh screen. Both flatness measurements and calculations are outside the scope of the present project. Note that while uneveness of the surface will generally reduce the measured reflectance, focusing is possible and will enhance the measured reflectance.

Improvements in the measurement include the addition of measurements using horizontal polarization and incorporation of phase and amplitude measurements at incrementally stepped positions of the transmitting horn. Measurements utilizing horizontal polarization, that is, for the electric field in the plane of incidence, will complete the description of specular reflection at 30^{o} incidence angle. These measurements can be made by incorporating waveguide twists into the transmitting and receiving arms of the present configuration. In conjunction with horizontal polarization measurements, the phase-amplitude measurements can determine the complex polarization transfer matrix of the sample so that at the 30^{o} incidence angle the reflection can be determined for any mesh orientation and incident polarization. An array of phase-amplitude measurements made as the transmitting horn is stepped toward the mesh sample can be Fourier transformed to very accurately determine the specific component of the received field traveling in the direction of the specular reflection. This processing technique would be inherently more accurate than the average of the minimum and maximum signal presently calculated from the amplitude only measurement. Phase-amplitude measurements can be made with available mixers and receiver and a stepping motor or manual precision linear drive.

Respectfully submitted,

Thomas B. Wells
Project Director

Approved:

Charles E. Ryan, Jr.
Chief,
EM Effectiveness Division

Mesh Reflectance Data (dB)

Band: ku
Frequency: 12.5
Sample No.: 1

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-1.20	
1(x)	-0.24	-1.35	-0.20
2(x)	-0.20	-1.30	-0.16
3(x)	-0.20	-1.25	-0.14
1(y)	-0.28	-1.40	-0.24
2(y)	-0.24	-1.40	-0.22
3(y)	-0.38	-1.50	-0.34

x Avg.	-0.17
y Avg.	-0.27
Total Avg.	-0.22

Mesh Reflectance Data (dB)

Band: ku
Frequency: 12.5
Sample No.: 2

Date: 10/5/82

Measurement	**Maximum**	**Minimum**	**Corrected Mean**
Ref.	0.00	-1.10	
1(x)	-0.08	-1.15	-0.07
2(x)	-0.20	-1.25	-0.18
3(x)	-0.10	-1.28	-0.13
1(y)	-0.10	-1.10	-0.06
Ref	0.00	-1.30	
2(y)	0.12	-1.30	-0.07
3(y)	-0.14	-1.25	-0.06

x Avg.	-0.13
y Avg.	-0.06
Total Avg.	-0.10

Mesh Reflectance Data (dB)

Band: ku
Frequency: 12.5
Sample No.: 3

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-1.19	
1(x)	-0.27	-1.32	-0.21
2(x)	-0.28	-1.38	-0.24
3(x)	-0.25	-1.38	-0.22
1(y)	-0.45	-1.4*	-0.34
2(y)	-0.50	-1.4*	-0.37
3(y)	-0.50	-1.4*	-0.37
x Avg.			-0.22
y Avg.			-0.36
Total Avg.			-0.29

*Actual minimum was smaller (corresponding to off-scale reading) therefore y-average should be considered an upper bound.

Mesh Reflectance Data (dB)

Band: ku
Frequency: 12.5
Sample No.: 4

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-1.08	
1(x)	-0.50	-1.4*	-0.42
2(x)	-0.40	-1.4*	-0.36
3(x)	-0.47	-1.4*	-0.40
1(y)	-0.50	-1.4*	-0.42
2(y)	-0.45	-1.4*	-0.39
3(y)	-0.45	-1.40	-0.39

x Avg.	-0.39
y Avg.	-0.40
Total Avg.	-0.40

*Actual minimum was smaller (corresponding to off-scale reading) therefore x and y averages should be considered upper bounds.

Mesh Reflectance Data (dB)

Band: ku
Frequency: 15.121
Sample No.: 1

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.60	
1(x)	-0.18	-0.80	-0.19
2(x)	-0.19	-0.64	-0.12
3(x)	-0.15	-0.68	-0.12
1(y)	-0.20	-0.90	-0.25
2(y)	-0.20	-0.98	-0.28
3(y)	-0.22	-1.22	-0.40

x Avg.	-0.14
y Avg.	-0.31
Total Avg.	-0.22

Mesh Reflectance Data (dB)

Band: ku
Frequency: 15.121
Sample No.: 2

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.64	
1(x)	-0.10	-0.75	-0.10
2(x)	-0.13	-0.79	-0.14
3(x)	-0.08	-1.00	-0.21
1(y)	-0.20	-1.00	-0.27
2(y)	-0.22	-0.98	-0.28
3(y)	-0.24	-1.00	-0.30

x Avg.	-0.15
y Avg.	-0.28
Total Avg.	-0.21

Mesh Reflectance Data (dB)

Band: ku
Frequency: 15.121
Sample No.: 3

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.64	
1(x)	-0.36	-0.98	-0.35
2(x)	-0.30	-0.88	-0.27
3(x)	-0.30	-0.85	-0.26
1(y)	-0.68	-1.15	-0.60
2(y)	-0.68	-1.24	-0.64
3(y)	-0.68	-1.20	-0.62

x Avg.	-0.29
y Avg.	-0.62
Total Avg.	-0.45

Mesh Reflectance Data (dB)

Band: ku
Frequency: 15.121
Sample No.: 4

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.64	
1(x)	-0.50	-1.12	-0.49
2(x)	-0.46	-1.08	-0.45
3(x)	-0.50	-1.04	-0.45
1(y)	-0.66	-1.40	-0.71
2(y)	-0.68	-1.4*	-0.72
3(y)	-0.64	-1.40	-0.70

x Avg.	-0.46
y Avg.	-0.71
Total Avg.	-0.58

*Actual minimum was smaller (corresponding to off-scale reading) therefore y-average should be considered an upper bound.

Mesh Reflectance Data (dB)

Band:	ku	**Date:**	10/5/82
Frequency:	18.0		
Sample No.:	1		

Measurement	**Maximum**	**Minimum**	**Corrected Mean**
Ref.	0.00	-0.24	
1(x)	-0.37	-0.42	-0.28
2(x)	-0.20	-0.54	-0.25
3(x)	-0.14	-0.56	-0.23
1(y)	-0.44	-0.56	-0.38
2(y)	-0.40	-0.58	-0.37
3(y)	-0.39	-0.58	-0.36
x Avg.			-0.25
y Avg.			-0.37
Total Avg.			-0.31

Mesh Reflectance Data (dB)

Band: ku
Frequency: 18.0
Sample No.: 2

Date: 10/5/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.25	
1(x)	-0.16	-0.36	-0.14
2(x)	-0.14	-0.38	-0.14
3(x)	-0.19	-0.39	-0.16
1(y)	-0.25	-0.56	-0.28
2(y)	-0.34	-0.60	-0.34
3(y)	-0.30	-0.61	-0.33

x Avg.	-0.15
y Avg.	-0.32
Total Avg.	-0.24

Mesh Reflectance Data (dB)

Band:	ku	**Date:**	10/5/82
Frequency:	18.0		
Sample No.:	3		

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.54	
1(x)	-0.48	-0.72	-0.34
2(x)	-0.42	-0.70	-0.30
3(x)	-0.48	-0.72	-0.34
1(y)	-0.68	-0.96	-0.56
2(y)	-0.78	-0.98	-0.62
3(y)	-0.73	-0.99	-0.60

x Avg.	-0.33
y Avg.	-0.59
Total Avg.	-0.46

Mesh Reflectance Data (dB)

Band: ku
Frequency: 18.0
Sample No.: 4

Date: 10/5/82

Measurement	**Maximum**	**Minimum**	**Corrected Mean**
Ref.	0.00	-0.30	
1(x)	-0.69	-0.84	-0.61
2(x)	-0.59	-0.82	-0.56
3(x)	-0.57	-0.68	-0.48
1(y)	-0.84	-1.20	-0.87
2(y)	-0.95	-1.15	-0.90
3(y)	-1.00	-1.38	-1.04
x Avg.			-0.55
y Avg.			-0.94
Total Avg.			-0.74

Mesh Reflectance Data (dB)

Band:	ka	**Date:**	10/5/82
Frequency:	26.5		
Sample No.:	1		

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.42	
1(x)	-0.30	-0.72	-0.30
2(x)	-0.34	-0.74	-0.33
3(x)	-0.30	-0.70	-0.29
1(y)	-0.20	-0.60	-0.19
2(y)	-0.17	-0.59	-0.17
3(y)	-0.24	-0.62	-0.22
x Avg.			-0.31
y Avg.			-0.19
Total Avg.			-0.25

Mesh Reflectance Data (dB)

Band: ka
Frequency: 26.5
Sample No.: 2

Date: 10/12/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	0.40	
1(x)	-0.30	-0.75	-0.32
2(x)	-0.33	-0.75	-0.33
3(x)	-0.34	-0.85	-0.39
1(y)	-0.72	-1.00	-0.66
2(y)	-0.70	-1.05	-0.68
3(y)	-0.68	-0.95	-0.62

x Avg.	-0.35
y Avg.	-0.65
Total Avg.	-0.50

Mesh Reflectance Data (dB)

Band: ka
Frequency: 26.5
Sample No.: 3

Date: 10/12/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.38	
1(x)	-0.86	-1.20	-0.84
2(x)	-0.84	-1.22	-0.84
3(x)	-0.79	-1.18	-0.79
Ref.	0.00	-0.40	
1(y)	-1.50	-1.80	-1.45
2(y)	-1.50	-1.90	-1.50
3(y)	-1.48	-1.70	-1.39

x Avg.	-0.82
y Avg.	-1.45
Total Avg.	-1.14

Mesh Reflectance Data (dB)

Band:	ka	**Date:**	10/12/82
Frequency:	26.5		
Sample No.:	4		

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.42	
1(x)	-1.00	-1.32	-0.95
2(x)	-1.02	-1.35	-0.98
3(x)	-1.02	-1.32	-0.96
Ref.	0.00	-0.40	
1(y)	-1.32	-1.60	-1.25
2(y)	-1.30	-1.60	-1.24
3(y)	-1.30	-1.62	-1.21

x Avg.	-0.96
y Avg.	-1.23
Total Avg.	-1.09

Mesh Reflectance Data (dB) dB

Band: ka
Frequency: 35.0
Sample No.: 1

Date: 10/13/82

Measurement	**Maximum**	**Minimum**	**Corrected Mean**
Ref.	0.00	-0.50	
1(x)	-0.36	-0.68	-0.27
2(x)	-0.42	-0.72	-0.32
3(x)	-0.35	-0.72	-0.29
1(y)	-0.44	-1.20	-0.56
2(y)	-0.40	-0.98	-0.44
3(y)	-0.50	-1.00	-0.50

x Avg.	-0.29
y Avg.	-0.50
Total Avg.	-0.40

Mesh Reflectance Data (dB)

Band: ka
Frequency: 35.0
Sample No.: 2

Date: 10/13/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.47	
1(x)	-0.40	-0.80	-0.37
2(x)	-0.40	-0.74	-0.34
3(x)	-0.42	-1.00	-0.47
1(y)	-0.70	-1.05	-0.64
2(y)	-0.74	-1.03	-0.65
3(y)	-0.60	-1.10	-0.61

x Avg.			-0.39
y Avg.			-0.63
Total Avg.			-0.51

Mesh Reflectance Data (dB)

Band: ka
Frequency: 35.0
Sample No.: 3

Date: 10/13/82

Measurement	**Maximum**	**Minimum**	**Corrected Mean**
Ref.	0.00	-0.41	
1(x)	-1.40	-1.80	-1.40
2(x)	-1.35	-1.65	-1.30
3(x)	-1.44	-1.77	-1.40
1(y)	-2.42	-2.58	-2.30
2(y)	-2.47	-2.60	-2.33
3(y)	-2.40	-2.55	-2.27

x Avg.	-1.37
y Avg.	-2.30
Total Avg.	-1.84

Mesh Reflectance Data (dB)

Band: ka
Frequency: 35.0
Sample No.: 4

Date: 10/13/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.48	
1(x)	-1.70	-1.95	-1.59
2(x)	-1.70	-2.05	-1.64
3(x)	-1.81	-2.10	-1.72
1(y)	-2.50	-2.80	-2.41
2(y)	-2.48	-2.77	-2.39
3(y)	-2.45	-2.77	-2.37

x Avg.	-1.65
y Avg.	-2.39
Total Avg.	-2.02

Mesh Reflectance Data (dB)

Band: ka
Frequency: 40.0
Sample No.: 1

Date: 10/13/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.34	
1(x)	-0.42	-0.74	-0.41
2(x)	-0.30	-0.62	-0.29
3(x)	-0.27	-0.60	-0.26
1(y)	-0.52	-0.85	-0.52
2(y)	-0.60	-0.97	-0.61
3(y)	-0.58	-0.90	-0.57

x Avg.	-0.32
y Avg.	-0.57
Total Avg.	-0.45

Mesh Reflectance Data (dB)

Band: ka
Frequency: 40.0
Sample No.: 2

Date: 10/13/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.40	
1(x)	-0.10	-0.50	-0.10
2(x)	-0.10	-0.50	-0.10
3(x)	-0.10	-0.50	-0.10
1(y)	-0.90	-1.10	-0.80
2(y)	-0.71	-1.00	-0.66
3(y)	-0.75	-1.05	-0.70

x Avg.	-0.10
y Avg.	-0.72
Total Avg.	-0.41

Mesh Reflectance Data (dB)

Band:	ka	**Date:**	10/13/82
Frequency:	40.0		
Sample No.:	3		

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.40	
1(x)	-2.00	-2.30	-1.95
2(x)	-1.90	-2.30	-1.90
3(x)	-1.95	-2.24	-1.90
1(y)	-2.90	-3.20	-2.85
2(y)	-2.90	-3.10	-2.80
3(y)	-2.95	-3.20	-2.88
x Avg.			-1.92
y Avg.			-2.84
Total Avg.			-2.38

Mesh Reflectance Data (dB)

Band: ka
Frequency: 40.0
Sample No.: 4

Date: 10/13/82

Measurement	Maximum	Minimum	Corrected Mean
Ref.	0.00	-0.41	
1(x)	-2.10	-2.30	-2.00
2(x)	-2.09	-2.30	-1.99
3(x)	-2.10	-2.30	-1.95
1(y)	-3.10	-3.25	-2.97
2(y)	-2.95	-3.15	-2.84
3(y)	-2.94	-3.20	-2.87
x Avg.			-1.98
y Avg.			-2.89
Total Avg.			-2.44